

REMARKS

Applicants have studied the Office Action dated November 15, 2004. It is submitted that the application, as amended, is now in condition for allowance. Claims 1, 3-10, 13, 15-22, and 24-28 are pending. Claims 2 and 14 are cancelled. Claims 11, 12, and 23 are withdrawn. Claims 1, 13, 24, and 26 have been amended. Reconsideration and allowance of the pending claims in view of the above amendments and the following remarks is respectfully requested.

In the Office Action, the Examiner:

- (1-3) required election of a single species under 35 U.S.C. § 121;
- (4) objected to claims 1-10 and 26-28 because of informalities;
- (5-6) rejected claims 13-22 under 35 U.S.C. § 112, second paragraph, as being incomplete for omitting essential steps;
- (7-8) rejected claims 1, 4, and 9 under 35 U.S.C. § 102(b) as being anticipated by Paniccia (U.S. Patent No. 6,251,706);
- (9) rejected claims 24-28 under 35 U.S.C. § 102(b) as being anticipated by Tustaniwskyj et al. (U.S. Patent No. 5,844,208);
- (10-11) rejected claims 3 and 10 under 35 U.S.C. § 103(a) as being unpatentable over Paniccia (U.S. Patent No. 6,251,706);
- (12) rejected claims 13, 15, 16, 21, and 22 under 35 U.S.C. § 103(a) as being unpatentable over Paniccia (U.S. Patent No. 6,251,706);
- (13) rejected claims 1-3, 7-10, 13-15, and 19-22 under 35 U.S.C. § 103(a) as being unpatentable over Paniccia (U.S. Patent No. 6,251,706) in view of Tustaniwskyj (U.S. Patent No. 5,844,208);
- (14) rejected claims 4, 6, 16, and 18 under 35 U.S.C. § 103(a) as being unpatentable over Paniccia (U.S. Patent No. 6,251,706) and Tustaniwskyj (U.S. Patent No. 5,844,208), as applied to claims 1-3, 7-10, 13-15, and 19-22, and further in view of Imada et al. (U.S. Patent Application Publication 2004/000157);and
- (15) rejected claims 5 and 17 under 35 U.S.C. § 103(a) as being unpatentable over Paniccia (U.S. Patent No. 6,251,706) and Tustaniwskyj (U.S. Patent No. 5,844,208), as applied to claims 1-3, 7-10, 13-15, and 19-22, and further in

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view of Tousignant (U.S. Patent No. 5,411,077).

(1-3) Election of Species under 35 U.S.C. § 121

As noted above, the Examiner required an election of a single species and a listing of all claims readable thereon.

A provisional election of Species 1, claims 1-10, 13-22, and 24-28 was made on September 17, 2004. Applicants affirm the election of Species 1, claims 1-10, 13-22, and 24-28. Claims 11, 13, and 23 are withdrawn from the application.

(4) Objection to Claims for Informalities

As noted above, the Examiner objected to claims 1-10 and 26-28 for informalities. Specifically, claim 1, as originally submitted, recited a photon detector that detects photons, but, according to the Examiner, did not clearly state which element emitted the photons.

Accordingly, claim 1 has been amended to recite "photons emitted from the electronic device." It is now believed claim 1 recites which element emits photons and that claim 1 is in condition for allowance.

The Examiner objected to claim 26 for informalities. Specifically, the Examiner stated that the body of the claim fails to provide an element for measuring thermal distribution, as recited in the preamble.

Accordingly, the preamble of claim 26 has been amended to recite "[a] system for allowing measurement of thermal distributions..." Applicant submits that a system that *allows* measurement is not required to have an element that actually *performs* the measuring. It is therefore believed that claim 26 is now in condition for allowance.

Further, claims 2-10, 27, and 28, depend from newly amended independent claims 1

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and 26. Since dependent claims contain all the limitations of the independent claims, claims 2-10, 27, and 28 should be allowable as well, which allowance is respectfully requested.

(5-6) Rejection under 35 U.S.C. § 112, Second Paragraph

As noted above, the Examiner rejected claims 13-22 under 35 U.S.C. § 112, second paragraph as being incomplete for omitting essential steps. Specifically, according to the Examiner, claim 13 omits the steps for measuring thermal distributions.

Applicants respectfully disagree with the Examiner's conclusion. Claim 13 recites:

A method for measuring thermal distributions of an electronic device during operation, the method comprising:

detecting, by a photon-detector, photons from an electronic device during operation of the electronic device, the photon detector located adjacent to a duct that is adjacent to the electronic device, wherein a coolant flows through the duct so as to cool the electronic device.

As explained on pages 16 and 17, paragraph 0054 and particularly 0055 of the instant application, the infrared camera 802 (photon-detector), by itself, captures and records thermal distributions. The first sentence of paragraph 0055 states "The thermal information and position information captured and recorded by infrared camera 802, i.e., the thermal distribution..." In other words, the single step of using a photon-detector to detect photons is, in fact, the step of measuring a thermal distribution.

It is therefore submitted that claim 13 of the instant application does not omit the step for measuring thermal distributions. Claim 13 is believed to be in condition for allowance. Further claims 14-22 depend from independent claim 13. Since dependent claims contain all the limitations of the independent claims, claims 14-22 should be allowable as well, which allowance is respectfully requested.

(7-9) Rejection under 35 U.S.C. § 102(b) Paniccia

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In item 8 of the Office action, the Examiner rejected claims 1, 4, and 9 under 35 U.S.C. § 102(b) as being anticipated by Paniccia (U.S. Patent No. 6,251,706). Independent claim 1 has been amended to distinguish and to more clearly define the present invention over Paniccia. Support for the changes is found on page 17, paragraph 0056, in the specification of the instant application as originally filed. No new matter has been added.

Before discussing the prior art in detail, it is believed that a brief review of the invention as claimed, would be helpful. Amended independent claim 1 recites, *inter alia*:

... a duct adapted to be coupled with an electronic device;
a coolant flowing through the duct so as to cool the electronic device; and
a photon detector located adjacent to the duct for detecting photons emitted from the electronic device, wherein the duct and the coolant are at least partially transparent to photons with wavelengths between about 0.1 micron to 20 microns. (emphasis added)

The present invention, as explained in detail on page 16, para. 0053 and FIG. 8 of the instant application, includes a duct (805) above and coupled to an electronic device (101). The duct (805) has an at least partially transparent upper wall (804) and uses an upper surface (103) of the electronic device (101) as its bottom wall. Within the duct (805) is a transparent fluid (806) that flows over the top surface (103) of the electronic device (101) in order to cool the device.

The Examiner states that Paniccia discloses a prior art system that anticipates the present invention. However, the cooling duct 130 of the prior-art system disclosed in Paniccia is a solid piece of metal. While coolant may be able to "pass across finned heat sink 130" shown in Paniccia (col. 3, lines 11 & 12), coolant cannot flow "through the duct so as to cool the electronic device", as recited in claim 1 of the instant application. More importantly, the solid metal cooling duct shown in FIG. 3A of Paniccia is not at all "partially transparent to photons." Instead, Paniccia shows a transparent heat "spreader" which guides the heat to a conventional cooling/heat sink system.

The Examiner cites 35 U.S.C. § 102(b) and a proper rejection requires that a single reference teach (i.e., identically describe) each and every element of the rejected claims as being anticipated by Paniccia.¹ Because the elements in independent claim 1 (at least "the duct and the coolant are at least partially transparent to photons") of the instant application is not taught or disclosed by Paniccia the apparatus of Paniccia does not anticipate the present invention. Dependent claims 4 and 9 are believed to be patentable as well because they are dependent on claim 1. Applicants respectfully submit that the Examiner's rejection under 35 U.S.C. § 102(b) has been overcome.

(9) Rejection under 35 U.S.C. § 102(b) Tustaniwskyj et al.

In item 9 of the Office action, the Examiner rejected claims 24-28 under 35 U.S.C. 102(b) as being anticipated by Tustaniwskyj et al. (U.S. Patent No. 5,844,208). Independent claims 24 and 26 have been amended to distinguish and to more clearly define the present invention over Tustaniwskyj et al. Support for the changes is found in FIG. 8 of the specification of the instant application as originally filed. No new matter has been added.

Before discussing the prior art in detail, it is believed that a brief review of the invention as claimed, would be helpful. Amended independent claim 24 recites, *inter alia*:

a duct adapted to be physically coupled directly to an electronic device; and

a coolant flowing through the duct so as to cool the electronic device, wherein the duct and the coolant are at least partially transparent to photons with wavelengths between about 0.1 micron to 20 microns.

Tustaniwskyj et al. are not concerned with measuring a thermal distribution of an electronic device, as is the present invention. Tustaniwskyj et al. describes and teaches a method and system to measure the temperature of a device by using a

¹ See MPEP §2131 (Emphasis Added) "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). "The identical invention must be shown in as complete detail as is contained in the ... claim."

heater (13) on the "back side" of the Si die (11). The temperature of the device (11) is measured with terminals (11a) coupled to the front side of the device (11). A laser (13a") generates an infrared laser beam, which works to heat a heater (13c") coupled to the device. In order to remove the heat from the heater (13c") a liquid cooled heat sink (14) is attached directly onto the heater (13c"), opposite the side of the heater (13b") attached to the device (11). That is, the heat sink (14) is not physically coupled directly to the electronic device, as is the present invention, as recited in newly amended claim 24.

Furthermore, the method/apparatus disclosed by Tustaniwskyj et al. (as does the Paniccia reference) describes and teaches various thermal interfaces creating thermal resistances between the electronic device and the multiple connecting components, including the heat sink. As discussed in the preceding paragraph, there is a heater (13c") between the electronic device (11) and the heat sink (14) in the Tustaniwskyj et al. invention. Every interface is difficult to control. Because Tustaniwskyj et al. is only concerned with controlling and measuring the electronic device temperatures, and not thermal imaging, the thermal interfaces of Tustaniwskyj et al. is not minimized.

However, the present invention is directed to thermal imaging and not simply temperature measurement. See FIG. 1B and accompanying description on pages 8, 9, and 10 of the specification of the instant application. It is important to fully understand the thermal behavior of the cooling package. For example, an apparent hot spot can be caused by non-uniformity in the heat removal caused by thermal interfaces between the electronic device and cooling package (which results into a measurement artifact) or by the power distribution in the microprocessor. In order to distinguish between these, it is necessary to understand the uniformity of the interfaces. Tustaniwskyj et al. simply do not teach or suggest a solution. Conversely, the invention of the instant application achieves far superior high-heat removal rates because the number of thermal interfaces is minimized and each is controlled.

The Examiner cites 35 U.S.C. § 102(b) and a proper rejection requires that a single reference teach (i.e., identically describe) each and every element of the rejected

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claims as being anticipated by either Tustaniwskyj et al.² Because the elements in independent claim 24 (at least "a duct adapted to be physically coupled directly to an electronic device") of the instant application is not taught or disclosed by Tustaniwskyj et al., the apparatus of Tustaniwskyj et al. does not anticipate the present invention. Dependent claims 25, 27, and 28 are believed to be patentable as well because they are ultimately dependent on claims 24 or 26. Accordingly, the present invention distinguishes over Tustaniwskyj et al. for at least this reason.

The Applicants respectfully submit that the Examiner's rejections under 35 U.S.C. § 102(b) have been overcome.

(10-11) Rejection under 35 U.S.C. § 103(a) Pannicia

As noted above, the Examiner rejected claims 3 and 10 under 35 U.S.C. § 103(a) as being unpatentable over Pannicia (U.S. Patent No. 6,251,706).

In the section entitled "(7-9) Rejection under 35 U.S.C. § 102(b) Paniccia" above, the deficiencies of the prior-art system disclosed in the Pannicia reference were discussed.

Claims 3 and 10 depend directly from newly amended claim 1. Independent claim 1 distinguishes over Paniccia. Since dependent claims contain all the limitations of the independent claims, claims 3 and 10 distinguishes over Paniccia, as well.

Accordingly, the Applicants respectfully submit that it is not necessary at this stage to address the Pannicia reference applied in the rejection of claims 3 and 10, and whether or not there is sufficient suggestion or motivation with a reasonable expectation of success for modifying the Pannicia reference, as required by MPEP § 2143. The Applicants respectfully request that the Examiner's rejection of claims 3 and 10 be withdrawn.

² See MPEP §2131 (Emphasis Added) "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). "The identical invention must be shown in as complete detail as is contained in the ... claim."

(12) Rejection under 35 U.S.C. § 103(a) Pannicia

As noted above, the Examiner rejected claims 13, 15, 16, 21, and 22 under 35 U.S.C. § 103(a) as being unpatentable over the *prior-art* method disclosed Pannicia (U.S. Patent No. 6,251,706). Independent claim 13 has been amended to contain the same limitations as newly amended claim 1.

In the section entitled "(7-9) Rejection under 35 U.S.C. § 102(b) Paniccia" above, the deficiencies of the prior-art system disclosed in the Pannicia reference were discussed. Claims 15, 16, 21, and 22 depend directly from newly amended claim 13. Independent claim 13 recites limitations that are analogous to newly amended claim 1 which has been shown to distinguish over Paniccia. Claim 13 therefore distinguishes over Pannicia for these same reasons. Further, since dependent claims contain all the limitations of the independent claims, claims 15, 16, 21, and 22 distinguish over Paniccia, as well. Accordingly, the Applicants respectfully submit that it is not necessary at this stage to address the Pannicia reference applied in the rejection of claims 13, 15, 16, 21 and 22, and whether or not there is sufficient suggestion or motivation with a reasonable expectation of success for modifying the Pannicia reference, as required by MPEP § 2143. The Applicants respectfully request that the Examiner's rejection of claims 13, 15, 16, 21 and 22, be withdrawn.

(13) Rejection under 35 U.S.C. § 103(a) Pannicia in view of Tustaniwskyj et al.

As noted above, the Examiner rejected claims 1-3, 7-10, 13-15, and 19-22 under 35 U.S.C. § 103(a) as being unpatentable over Pannicia (U.S. Patent No. 6,251,706) in view of Tustaniwskyj et al. (U.S. Patent No. 5,844,208).

The apparatus and method of Paniccia is very different from the present invention. Paniccia discloses a passive IR-transparent heat spreader and a heat sink (which is not IR-transparent). The non-IR-transparent heat sink (534) has a void in its center and makes contact with the edges of a "heat slug" (521) and not the chip itself. The heat slug is in contact with the chip.

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Paniccia uses the heat slug to *guide* the heat to the heat sink. In other words the heat slug is an IR-transparent thermal conductor, which does not involve any mass transport of coolant, and specifically the heat slug does not have "a coolant flowing through the duct so as to cool the electronic device," as recited in claim 1 of the instant application. Consequently, the heat removal rate of the Paniccia device is very low in comparison to the present invention.

In contrast to Paniccia, the instant application discloses an active IR-transparent heat sink. The heat sink of the present invention utilizes coolant that flows directly through the heat sink and over the device, resulting in a greatly enhanced and far superior heat removal rate than the Paniccia invention.

Furthermore, Paniccia relies on a thermal interface material (e.g., oil) between the heat slug and the back side of the chip. In contrast, the present invention couples a duct directly to the device and the coolant flows in the duct and over the back side of the die.

See Fig. 8. Si is wetted very well by IR transparent fluids (non-polar fluids), which means that the heat removal rate is highly reproducible with the present invention.

The apparatus of Tustaniwskyj et al. is also very different from the present invention. It is important to recognize that it is not a goal of the Tustaniwskyj et al. reference to measure thermal distributions. Nor is Tustaniwskyj et al. concerned with reducing the number of thermal interfaces between the device and the heat sink. As a result, Tustaniwskyj et al. does not suggest using a photon detector located adjacent to a duct. Tustaniwskyj et al. measures temperature only and utilizes test leads (12) to take the measurements. Furthermore, unlike the present invention, the temperature measurement is taken on the side of the device opposite that of the heat sink.

Similar to Pannicia, Tustaniwskyj et al. relies on multiple thermal interfaces (14f"-14a", 14a"-14e", 14e"-13c", 13d"-11), creating a heat removal rate that is highly varying from unit to unit.

The Statute expressly requires that obviousness or non-obviousness be determined for the claimed subject matter "as a whole," and the key to proper determination of the differences between the prior art and the present invention is giving full recognition to the invention "as a whole." The Pannicia reference taken alone or in view of Tustaniwskyj et al. simply does not suggest, teach or disclose the patentably distinct limitations of:

a duct adapted to be coupled with an electronic device;
a coolant flowing through the duct so as to cool the electronic device; and
a photon detector located adjacent to the duct for detecting photons emitted from the electronic device, wherein the duct and the coolant are at least partially transparent to photons with wavelengths between about 0.1 micron to 20 microns.

The limitations taken "as a whole" in independent claims 1 and 13 are not present in Pannicia taken alone and/or in view of Tustaniwskyj et al.

Very recently, the Federal Circuit again took up the identical question of Obviousness in combining references in the case *In re Sang Su Lee*, No. 00-1158 (January 18, 2002). In this case, the Board of Patent Appeals rejected all of Applicant's pending claims as obvious under § 103. The Federal Circuit vacated and remanded. Citing two prior art references, the Board stated that a person of ordinary skill in the art would have been motivated to combine the references based on "common knowledge" and "common sense," but it did not present any specific source or evidence in the art that would have otherwise suggested the combination. Here the Examiner, on page 9, is citing "*it would have been obvious to one having ordinary skill at the time the invention was made to modify the system disclosed by Pannicia by replacing the passive heat sink with an active heat sink, as taught by Tustaniwskyj et al., in order to remove more heat from the device with the coolant and provide faster cooling of the device*" without more.³ The Federal Circuit held that the Board's rejection of a need for any specific hint or suggestion in the art to combine the references was both legal error and arbitrary

³ If, however, the Examiner's statements are based on facts within the personal knowledge of the Examiner, the Applicant respectfully requests that the Examiner support these references by filing an affidavit as is allowed under MPEP §707 citing 37 CFR 1.104(d)(2).

agency action subject to being set aside by the court under the Administrative Procedure Act (APA). Accordingly, without any suggestion or motivation found in Paniccia in view of Tustaniwskyj et al., the Examiner has failed to properly establish a prima facie case of obviousness of the invention as a "whole." The Applicants submit the present invention distinguishes over Paniccia in view of Tustaniwskyj et al. for at least this reason as well.

For the foregoing reasons, independent claims 1 and 13, as amended, distinguish over Paniccia taken alone and/or in view of Tustaniwskyj et al. Claims 3 and 7-10 depend from claim 1 and claims 14, 15, and 19-22 depend from claim 13. Since dependent claims contain all the limitations of the independent claims, claims 3, 7-10, 14, 15, and 19-22 distinguish over Paniccia in view of Tustaniwskyj et al., as well, and the Examiner's rejection should be withdrawn.

(14) Rejection under 35 U.S.C. § 103(a) Paniccia and Tustaniwskyj et al.
in view of Imada et al.

As noted above, the Examiner rejected claims 4, 6, 16, and 18 under 35 U.S.C. § 103(a) as being unpatentable over Pannicia (U.S. Patent No. 6,251,706) and Tustaniwskyj et al. (U.S. Patent No. 5,844,208), as applied to claims 1-3, 7-10, 13-15, and 19-22 above, and further in view of U.S. Patent Application Publication 2004/000157 to Imada et al.

As stated in the preceding section, Applicant's submit independent claims 1 and 13, as amended, distinguish over Paniccia taken alone and/or in view of Tustaniwskyj et al. Since claims 4 and 6 depend from claim 1 and claims 16 and 18 depend from claim 13, it is also believed that claims 4, 6, 16 and 18 are distinguished over Paniccia taken alone and/or in view of Tustaniwskyj et al. without regard to the Imada et al. reference.

The Statute expressly requires that obviousness or non-obviousness be determined for the claimed subject matter "as a whole," and the key to proper determination of the differences between the prior art and the present invention is giving full recognition to

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the invention "as a whole." The Pannicia reference taken alone or in view of Tustaniwskyj et al., and further in view of Imada et al. simply does not suggest, teach or disclose the patentably distinct limitations of:

a duct adapted to be coupled with an electronic device;
a coolant flowing through the duct so as to cool the
electronic device; and
a photon detector located adjacent to the duct for detecting
photons emitted from the electronic device, wherein the duct and
the coolant are at least partially transparent to photons with
wavelengths between about 0.1 micron to 20 microns.

The limitations taken "as a whole" in independent claims 1 and 13 are not present in Pannicia taken alone and/or in view of Tustaniwskyj et al. and further in view of Imada et al.

For the foregoing reasons, independent claims 1 and 13, as amended, distinguish over Pannicia taken alone and/or in view of Tustaniwskyj et al. and further in view of Imada et al. Claims 4 and 6 depend from claim 1 and claims 16 and 18 depend from claim 13. Since dependent claims contain all the limitations of the independent claims, claims 4, 6, 16, and 18 distinguish over Pannicia alone or in view of Tustaniwskyj et al. and/or in further view of Imada et al., as well, and the Examiner's rejection should be withdrawn.

(15) Rejection under 35 U.S.C. § 103(a) Pannicia and Tustaniwskyj et al.
in view of Tousignant

As noted above, the Examiner rejected claims 5 and 17 under 35 U.S.C. § 103(a) as being unpatentable over Pannicia (U.S. Patent No. 6,251,706) and Tustaniwskyj et al. (U.S. Patent No. 5,844,208), as applied to claims 1-3, 7-10, 13-15, and 19-22 above, and further in view of Tousignant (U.S. Patent No. 5,411,077).

The Statute expressly requires that obviousness or non-obviousness be determined for the claimed subject matter "as a whole," and the key to proper determination of the differences between the prior art and the present invention is giving full recognition to the invention "as a whole." The Pannicia reference taken alone or in view of

Tustaniwskyj et al., and further in view of Tousignant simply does not suggest, teach or disclose the patentably distinct limitations of:

- a duct adapted to be coupled with an electronic device;
- a coolant flowing through the duct so as to cool the electronic device; and
- a photon detector located adjacent to the duct for detecting photons emitted from the electronic device, wherein the duct and the coolant are at least partially transparent to photons with wavelengths between about 0.1 micron to 20 microns.

The limitations taken "as a whole" in independent claims 1 and 13 are not present in Pannicia taken alone and/or in view of Tustaniwskyj et al. and further in view of Tousignant.

For the foregoing reasons, independent claims 1 and 13 as amended distinguish over Panicia taken alone and/or in view of Tustaniwskyj et al. and further in view of Tousignant. Claim 5 depends from claim 1 and claim 17 depends from claim 13. Since dependent claims contain all the limitations of the independent claims, claims 5 and 17 distinguish over Panicia alone or in view of Tustaniwskyj et al. and/or in further view of Tousignant, as well, and the Examiner's rejection should be withdrawn.

CONCLUSION

In this Response, Applicant has amended certain claims. In light of the Office Action, Applicant believes these amendments serve a useful clarification purpose, and are desirable for clarification purposes, independent of patentability. Accordingly, Applicants respectfully submit that the claim amendments do not limit the range of any permissible equivalents.

Applicant acknowledges the continuing duty of candor and good faith to disclosure of information known to be material to the examination of this application. In accordance with 37 CFR §1.56, all such information is dutifully made of record. The foreseeable equivalents of any territory surrendered by amendment are limited to the territory taught

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by the information of record. No other territory afforded by the doctrine of equivalents is knowingly surrendered and everything else is unforeseeable at the time of this amendment by the Applicants and their attorneys.

Applicant respectfully submits that all of the grounds for rejection stated in the Examiner's Office Action have been overcome, and that all claims in the application are allowable. No new matter has been added. It is believed that the application is now in condition for allowance, which allowance is respectfully requested.

It is believed that no fee is due with this Amendment. However, if any fees are due, the Commissioner is hereby authorized to charge any fees that may be required or credit any overpayment to Deposit Account 50-1556.

PLEASE CALL the undersigned if that would expedite the prosecution of this application.

Respectfully submitted,

Date: January 26, 2005

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